121(3572)

Proceedings of the United States National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 121 1967 Number 3572

CALIGOID COPEPODS PARASITIC ON SHARKS OF THE INDIAN OCEAN

By ROGER F. CRESSEY

SMITHSONIAN PRESS

Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 121 1967 Number 3572

CALIGOID COPEPODS PARASITIC ON SHARKS OF THE INDIAN OCEAN

By Roger F. Cressey
Associate Curator, Division of Crustacea

During the International Indian Ocean Expedition, 35 species of caligoid copepods were collected from 29 species of sharks. The author collected during Cruise 5 of the R.V. *Anton Bruun* and also at Nosy Bè, Madagascar (Malagasy Republic). In addition, several other participants collected copepods and donated the material to the author for inclusion in this study.

Of the 35 species of copepods collected, 8 of them were new. Four of these new species, all members of the Eudactylinidae, are described here. Two of the others represented new genera (*Pagina* and *Bariaka*) and each has been described separately elsewhere. The remaining 2 new species are members of the Pandaridae and are being described in a paper currently in press revising the entire family.

A map of the Indian Ocean showing points of collection is included (fig. 54). All station numbers refer to points on the various cruise tracks of the R.V. *Anton Bruun*. In text tabulations, Roman numerals refer to spines, Arabic to setae.

I would like to thank the following persons for their efforts on my behalf: Dr. Richard Gooding, University of Singapore; Miss Sherril

Kite, Woods Hole Oceanographic Institution; Dr. Alan Lewis, University of British Columbia; Mr. Richard Shomura, Bureau of Commercial Fisheries; Dr. Marta Vannucci, University of São Paulo; and Miss Leonie Joubert, University of Natal, who sent a number of collections from sharks caught near Durban, South Africa, that I have included in this paper.

I would like to acknowledge the support of the National Science Foundation-U.S. Program in Biology for the field portion of this work.

All material has been deposited in the U.S. National Museum.

Family Pandaridae Milne-Edwards, 1840

Pandarus cranchii Leach, 1819

Collections: From 22 specimens of *Carcharinus longimanus* (Poey) at stations 108, 109, 113, 118, 139, 141, 144, 147, 289, 291, 293, 295, 297, 298, 323, 326, 411, 415, 417, and 418; from 1 specimen of the same host off Durban, South Africa; from 4 specimens of *Carcharinus floridanus* (Bigelow and Schroeder) at stations 111, 289, 293, and 326; from 1 specimen of *Alopias vulpinus* at station 115; from 1 specimen of *Carcharodon carcharias* from Durban.

Habitat: Body surface and fins.

Pandarus smithii Rathbun, 1886

Collections: From 2 specimens of *Alopias vulpinus* (Bonneterre) at stations 288 and 289; from 1 specimen of *Isurus oxyrinchus* Rafinesque at station 282; from 1 specimen of *Carcharinus floridanus* at station 144.

Habitat: Body surface and fins.

Pandarus satyrus Dana, 1852

Collections: From 6 specimens of *Prionace glauca* (Linnaeus) at stations 124, 292, 295, 306, 311, and 324.

Habitat: Body surface and fins.

Pandarus carcharini Ho, 1963

Collections: From 3 specimens of *Carcharinus maculipinnis* (Poey) from Nosy Bé, Madagascar; from 2 specimens of *Carcharinus leucas* (Valenciennes) from Nosy Bé and 1 specimen of the same host from Durban.

Habitat: Body surface and fins.

Pandarus niger Kirtesinghe, 1950

Collections: From 10 specimens of *Carcharinus* species at stations 408 and 409; from 1 specimen of *Carcharinus spallanzani* (Boneparte) at station 407.

Habitat: Body surface and pectoral fins.

***Pseudopandarus gracilis* Kirtesinghe, 1950**

Collections: From 1 specimen of *Scoliodon palasorrah* (Bleeker) from Nosy Bé; from 1 specimen of *Scoliodon* species at station 412.

Habitat: Body surface and fins.

***Pseudopandarus longus* (Gnanamuthu, 1951)**

Collections: From 7 specimens of *Rhizoprionodon* species at station 402 (Beira Harbor); from 2 specimens of *Carcharinus tjutjot* at the same location; from 1 specimen of *Carcharinus obesus* and *Rhizoprionodon acutus* both from Durban.

Habitat: Body surface.

This copepod was originally assigned to the genus *Pandarus* by Gnanamuthu, but I have placed it in the genus *Pseudopandarus*. A discussion of this species together with my reasons for the change can be found in my paper (1966b) revising the Pandaridae.

***Gangliopus pyriformis* Gerstaecker, 1854**

Collections: From 2 specimens of *Prionace glauca* at stations 292 and 295; from 3 specimens of *Alopias vulpinus* at stations 106, 109, and 115.

Habitat: Gill filaments.

***Phyllothereus cornutus* (Milne-Edwards, 1840)**

Collections: From 2 specimens of *Prionace glauca* at stations 292 and 306.

Habitat: Gill filaments.

***Perissopus dentatus* Steenstrup and Lütken, 1861**

Collections: From 1 specimen of *Carcharinus tjutjot* at station 402; from 1 specimen of *Mustelus* species, from 1 specimen of *Carcharinus obscurus*, from 1 specimen of *Carcharinus leucas*, all from Durban.

Habitat: Caudal fin and right clasper.

***Echthrogaleus coleoptratus* (Guerin, 1837)**

Collections: From 5 specimens of *Prionace glauca* at stations 131, 132, 306, and 309; from 2 specimens of *Lamna* species (mackerel shark) at stations 132 and 309.

Habitat: Body surface.

***Echthrogaleus denticulatus* Smith, 1874**

Collections: From 3 specimens of *Alopias vulpinus* at stations 106, 109, 110, 115, 288, and 289; from 2 specimens of *Isurus oxyrinchus* Rafinesque at stations 106, 108, 123, and 282.

Habitat: Body surface, sometimes in large clusters around vent of female.

***Dinemoura latifolia* (Steenstrup and Lütken, 1861)**

Collections: From 2 specimens of *Isurus oxyrinchus* at stations 123, 139, 296, and 310; from 1 specimen of *Isurus glaucus* from Durban.

Habitat: Body surface.

***Dinemoura* species**

Collections: From 2 specimens of *Alopias vulpinus* at stations 289 and 295; from 1 specimen of *Alopias superciliosus* (Lowe) at Nosy Bé and station 119.

Habitat: Ventral body surface.

This new species is described in detail in my paper (1967) revising the Pandaridae.

***Pagina tunica* Cressey, 1964**

Collections: From 2 specimens of *Alopias superciliosus* from Nosy Bé and Majunga, Madagascar, and station 119.

Habitat: Body surface (usually ventral).

***Nesippus orientalis* Heller, 1868**

Collections: From 6 specimens of *Carcharinus maculipinnis*, 4 specimens of *Sphyrna lewini* (Griffith), 3 specimens of *Carcharinus leucas*, 1 specimen of *Galeocerdo cuvier* (Peron and LeSueur), 1 specimen of *Rhizoprionodon acutus*, 1 specimen of *Scoliodon palasorrah*, all from Nosy Bé; from 1 specimen of *Sphyrna mokarran* (Rüppell) at station 409; from 1 specimen of *Sphyrna zygaena* (Linnaeus) from Durban; from 2 specimens of *Carcharodon carcharias* from Durban.

Habitat: Roof of mouth and gill arches.

***Nesippus crypturus* Heller, 1865**

Collections: From 13 specimens of *Carcharinis maculipinnis*, 5 specimens of *Sphyrna lewini*, 5 specimens of *Carcharinus leucas*, 1 specimen of *Galeocerdo cuvier*, all from Nosy Bé; from 1 specimen of *Carcharinus longimanus* at station 291; from 1 specimen of *Carcharinus leucas* at station 409; from 1 specimen of *Sphyrna mokarran* at station 409; from 1 specimen of *Carcharinus* species (*floridanus*?) at station 412.

Habitat: Roof of mouth and gill arches.

***Nesippus* species**

Collections: From 1 specimen of *Galeocerdo cuvier* from Nosy Bé; from 1 specimen of the same host caught off Comores Island (Zaudsi).

Habitat: Nasal cavities.

This new species is described in detail in my paper (1967) revising the Pandaridae.

Family Euryphoridae Wilson, 1905

Alebion gracilis Wilson, 1905

Collections: From 1 specimen of *Carcharinus albimarginatus* at station 400; from 1 specimen of *Carcharinus leucas* at station 409; from 1 specimen of *Carcharinus* species at station 381; from 1 specimen of *Carcharinus* species at station 412; from 1 specimen of *Galeocerdo cuvier* from Comores Island; from 1 specimen of *Carcharinus longimanus* at station 291; from 1 specimen of *Carcharinus obscurus* from Durban.

Habitat: Body surface and fins (dorsal surface usually).

Alebion alatus Gnanamuthu, 1951

Collection: From 1 specimen of *Carcharinus limbatus* from Nosy Bé.

Habitat: Body surface.

This copepod was originally described from a carcharinid shark of India and this new record is only the second record of this species.

Alebion elegans Capart, 1953

Collection: From 1 specimen of *Sphyrna mokarran* at station 409.

Habitat: Caudal fin.

This copepod has previously been reported from the west coast of Africa (Capart, 1953, and Vaissière, 1959). This record extends the known range to the east coast of Africa.

Paralebion elongatus Wilson, 1911

Collections: From 7 specimens of *Carcharinus leucas* from Nosy Bé; from 1 specimen of the same host from Durban.

Habitat: Mouth and gill arches.

This parasite is probably worldwide in its distribution. I have collections from the Atlantic and Pacific as well as the Indian Ocean. It is the only euryphorid that is routinely found in the mouth of the host.

Family Anthosomatidae Dana, 1853

Anthosoma crassum (Abildgaard, 1794)

Collection: From 1 specimen of *Isurus* species caught off East London, South Africa; from 1 specimen of *Isurus oxyrinchus* at station 139.

Habitat: Near base of teeth of the host.

This copepod has been reported many times and apparently is worldwide in distribution.

Family Eudactylinidae Yamaguti, 1963

Nemesis lamna Risso, 1826

Collections: From 2 specimens of *Isurus oxyrinchus* at stations 296 and 310; from 2 specimens of *Isurus* species and 1 specimen of *Carcharodon carcharias* from Durban.

Habitat: Gill filaments.

Nemesis versicolor Wilson, 1913

Collections: From 12 specimens of *Carcharinus maculipinnis* from Nosy Bé.

Habitat: Gill filaments.

Nemesis robusta (Beneden, 1851)

Collections: From 1 specimen of *Sphyrna mokarran* at station 409; from 2 specimens of *Sphyrna lewini* and 4 specimens of *Carcharinus leucas* from Nosy Bé.

Habitat: Gill filaments.

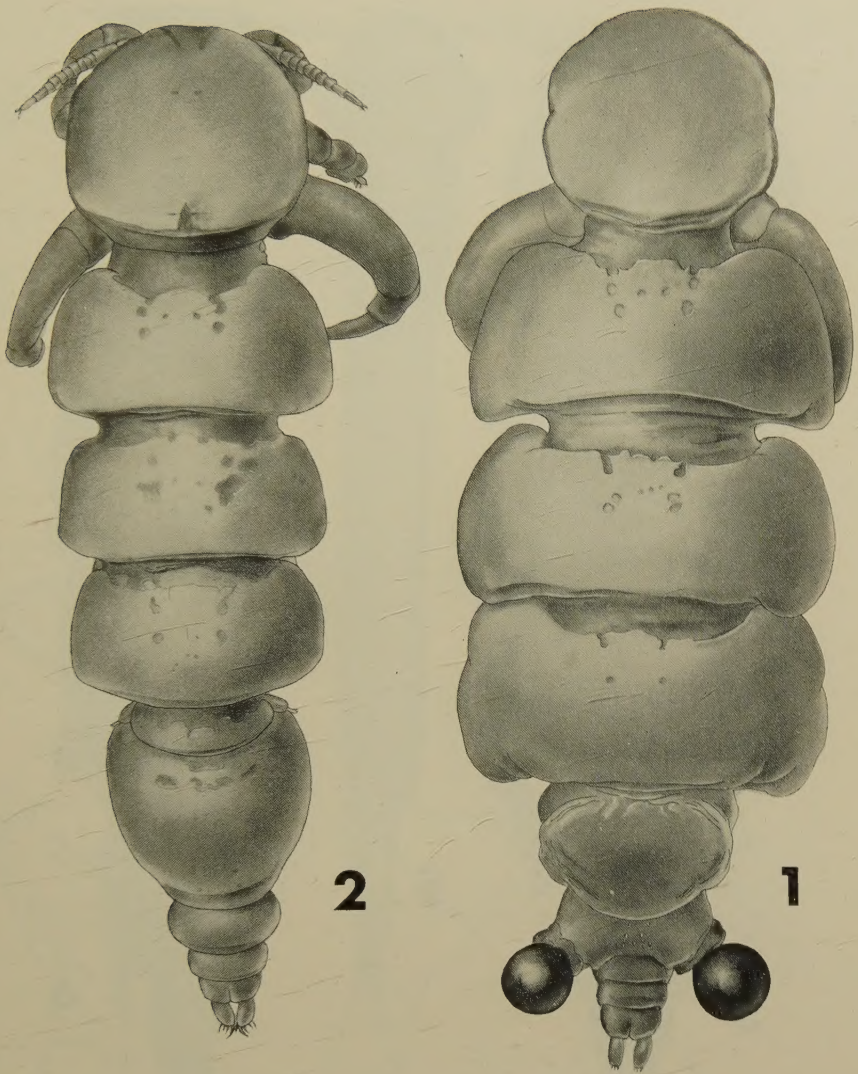
Nemesis aggregatus, new species

FIGURES 1, 2, 6–20

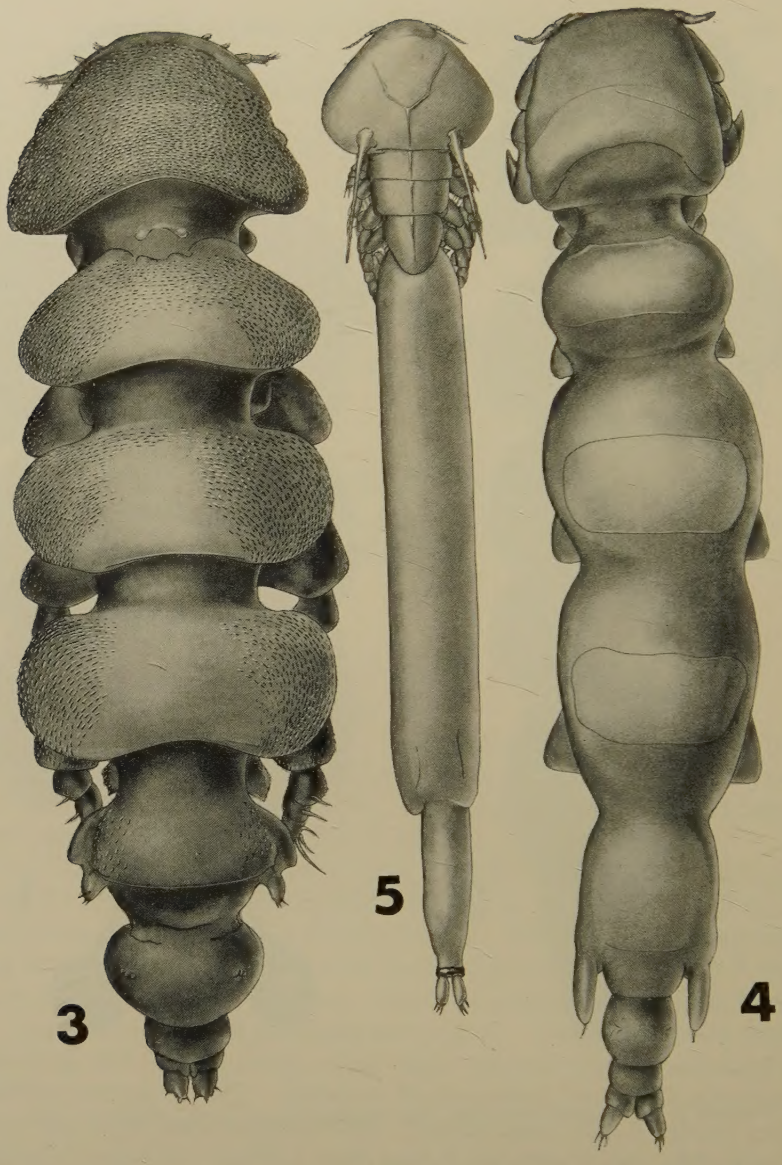
Collections: From 5 specimens of *Alopias vulpinus* at stations 109, 110, 115, 288, and 289. Material from station 288 designated as types. Holotype, female, USNM 113291. Allotype, male, USNM 113292. Paratypes female and male USNM 113293.

FEMALE.—Body form as in figure 1. Total length 4.5 mm. Greatest width 1.5 mm. Cephalon slightly longer than wide (1.3 by 1.2 mm), comprising nearly one-third of body length. First pedigerous segment (2nd thoracic segment) fused with head. Thoracic segments 3–5 free, about equal in length (0.85 mm). Thoracic segment bearing leg 5 free, not combined to form genital segment (fig. 6). Genital segment wider than long (0.7 by 0.4 mm), often with spermatophores attached at posterior corners (fig. 6). Abdomen 3-segmented, segments measuring 140μ, 103μ, and 140μ respectively. Caudal rami (fig. 7) about twice as long as wide (85μ by 40μ), each with 6 posterior setae. All setae of about equal length, 2 broad and blunt as in figure.

First antenna (fig. 8) of 12 segments, bearing short setae. Second antenna (fig. 9) in form of claw, terminal segment with 2 short setae. Second segment with patch of 10–12 short, broad, spinules on inner surface. Mouth tube and mandible as in other members of genus. First maxilla (fig. 10) biramose, each ramus with 2 terminal setae. Second maxilla, in general, as in other members of genus. Tip armed as in figure 11. Maxilliped (fig. 12) in form of stout claw.



FIGURES 1–2.—*Nemesis aggregatus*, new species, dorsal view: 1, female; 2, male.

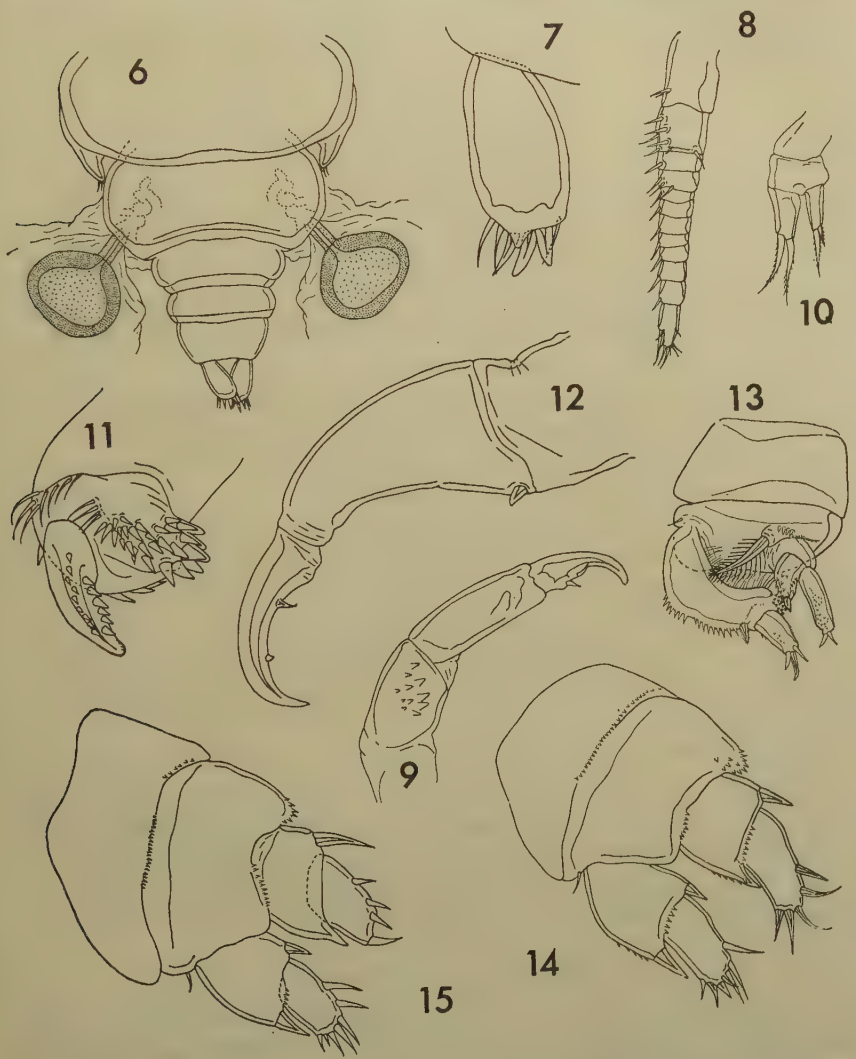


FIGURES 3–5.—*Eudactylina pusilla*, new species: 3, dorsal view, female. *Eudactylina pollex*, new species: 4, dorsal view, female. *Kroyeria gemursa*, new species: 5, dorsal view, female.

Legs 1–4 (figs. 13–16) biramose, all rami 2-segmented. Spine and setal formula as follows:

	leg 1		*leg 2*		*leg 3*		*leg 4*	
	exo.	end.	exo.	end.	exo.	end.	exo.	end.
seg. 1	I:0	0:I	I:I	0:I	I:I	0:I	I:I	0:I
seg. 2	III	II	VII	V	VII	IV	VIII	IV

Leg 1 with endopod turned so that inner edge faces exopod. First segment of exopod curved toward endopod forming chela-like struc-



FIGURES 6–15.—*Nemesis aggregatus*, new species, female: 6, abdomen, dorsal; 7, caudal ramus; 8, first antenna; 9, second antenna; 10, first maxilla; 11, tip of second maxilla; 12, maxilliped; 13, first leg; 14, second leg; 15, third leg.

ture. Legs 2–4 with rows of spinules as indicated in figures. Leg 5 (see fig. 6) a lobe on posterior corner of thoracic segment 5 bearing 3 short setae. Leg 6 absent.

Egg strings uniseriate, long.

MALE.—Body form as in figure 2. Total length 4.0 mm. Greatest width 1.0 mm. Genital segment as long as wide (0.8 mm). Configuration of body otherwise as in female. Caudal rami as in female.

Oral area and cephalic appendages as in female.

Legs 1–4 biramose. All rami 2-segmented. Spine and setal formula as follows:

	leg 1		*leg 2*		*leg 3*		*leg 4*	
	exo.	end.	exo.	end.	exo.	end.	exo.	end.
seg. 1	I:0	0:I	I:1	0:1	I:1	0:1	I:1	0:1
seg. 2	III	II	IV:3	6	III:4	5	III:5	5

Legs 2–4 (figs 17, 18, and 19) armed as in figures. Terminal endopod segment of leg 3 bearing a modified seta as shown in figure 18. Terminal endopod segment of leg 4 also with modified seta but differing from that of leg 3 (compare figs. 18 and 19). Leg 5 a lobe with 3 setae along distal border and 1 seta near base of lobe. Segment bearing leg 5 small and inconspicuous. Leg 6 (fig. 20) a broad lobe on ventrodistal corner of genital segment bearing 3 setae, innermost twice as long as outer 2.

REMARKS.—This species differs from *N. pallida* Wilson, *N. vermi* Scott, *N. robusta* (van Beneden), *N. atlantica* Wilson, *N. pilosa* Pearse, and *N. macrocephalus* Shiino by the nature of the spinules on segment 2 of the second antenna. In *N. aggregatus* there is a patch of 10–12 prominent spinules on this segment whereas in the above-mentioned species this patch is composed of 25–40 small spinules. *Nemesis tiburo* and *N. versicolor* differ from *N. aggregatus* in the presence of a row of fine spinules on segment 3 of second antenna in addition to those on segment 2.

Habitat: The parasites were found attached to the free end of each gill filament nearest to the gill slit. The tissue at the site of attachment was swollen and pale in color (normally red). Each gill filament could carry as many as 8 copepods on its tip.

The name *aggregatus* from Latin, meaning "clustered or united," refers to the appearance of the species.

Eudactylina aspera Heller, 1865

Collections: From 8 specimens of *Carcharinus maculipinnis;* from 2 specimens of *Rhizoprionodon acutus;* from 1 specimen of *Sphyrna lewini;* all from Nosy Bé.

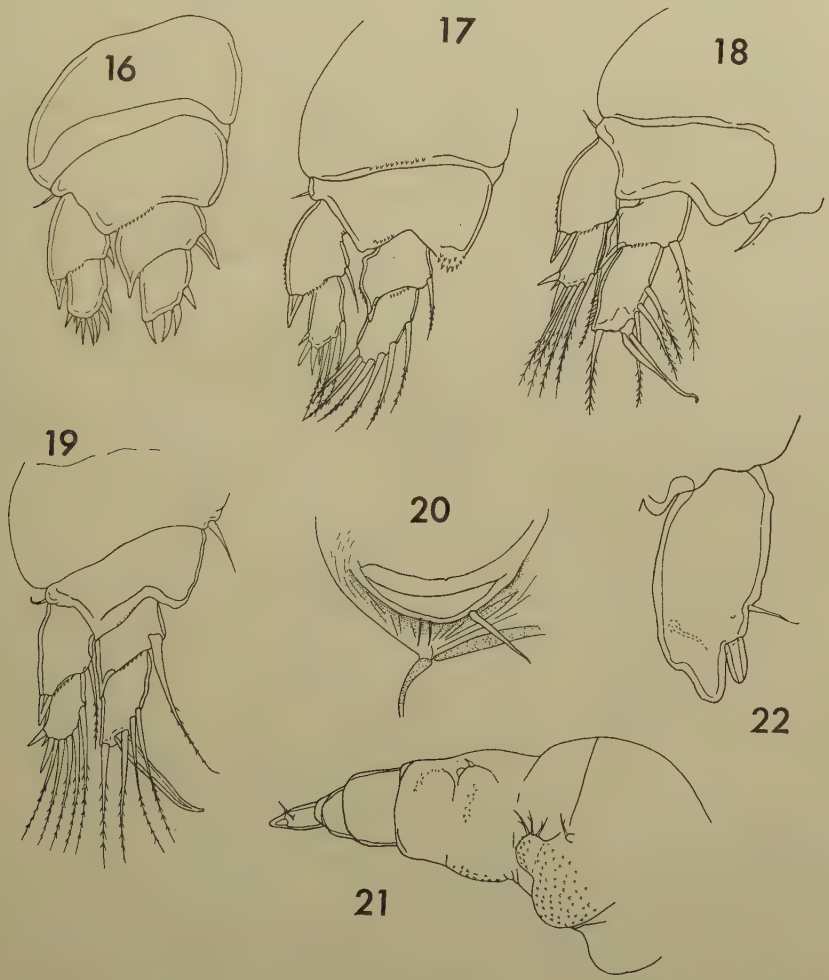
Habitat: Gill filaments.

Eudactylina pusilla, new species

FIGURES 3, 21–30

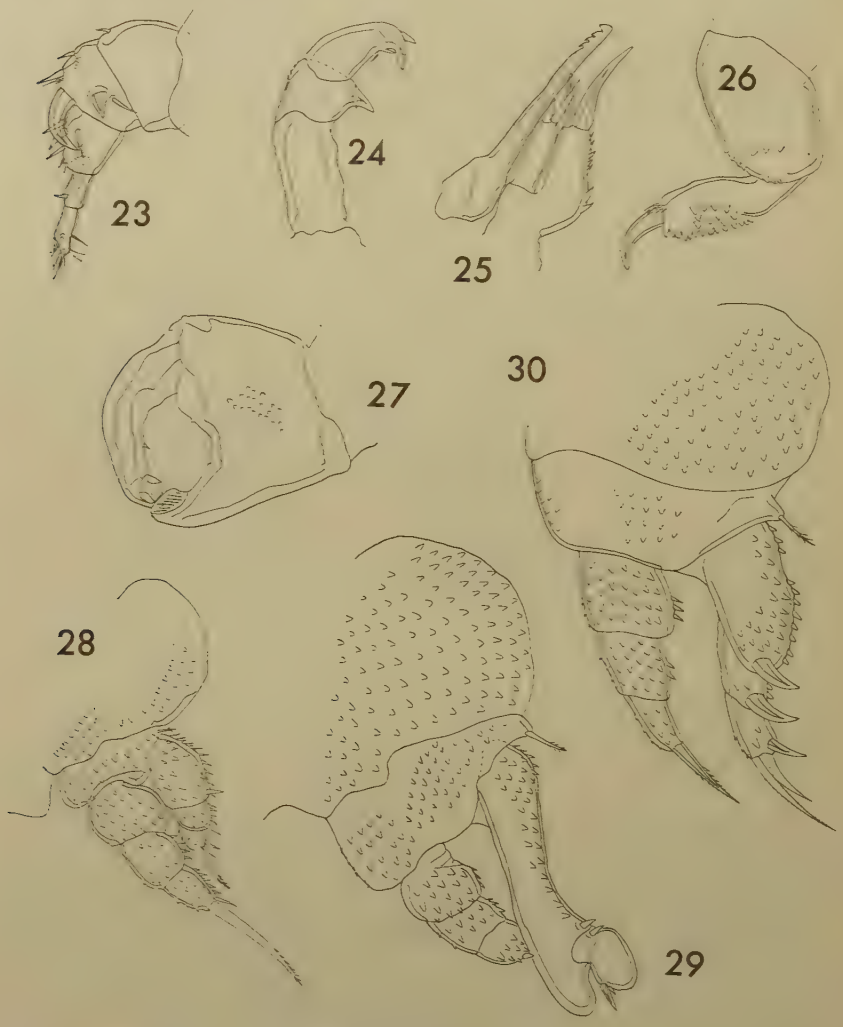
Collection: 3 females from 1 specimen of *Galeocerdo cuvier* from Nosy Bé. Holotype USNM 113299. Paratype USNM 113300. One specimen dissected for study.

FEMALE.—Body form as in figure 3. Dorsal surface of body covered with broad spinules. Total length 4.6 mm. Greatest width 1.3 mm. Cephalon wider than long (1.3 by 0.8 mm), widest posterolaterally. First pedigerous thoracic segment fused with head.



FIGURES 16–22.—*Nemesis aggregatus*, new species, male: 16, fourth leg; female: 17, second leg; 18, third leg; 19, fourth leg; 20, sixth leg. *Eudactylina pusilla*, new species, female: 21, abdomen and genital segment, lateral; 22, caudal ramus.

Thoracic segments 3–5 free. Thoracic segment bearing leg 5 free, not combined to form genital segment. Genital segment (fig. 21) somewhat wider than long (0.8 by 0.7 mm). Abdomen 2-segmented. Caudal ramus (fig. 22) terminating in blunt process with accessory spine and 2 subterminal setae.



FIGURES 23–30.—*Eudactylina pusilla*, new species, female: 23, first antenna; 24, second antenna; 25, mandible and first maxilla; 26, second maxilla; 27, maxilliped; 28, first leg; 29, second leg; 30, fourth leg.

First antenna (fig. 23) 5-segmented, second segment with stout clawlike spine on outer distal corner. Other segments armed as in figure. Second antenna (fig. 24) 3-segmented, second segment

with sclerotized process on inner border. Terminal segment with clawlike spine at tip. Mandible and first maxilla (fig. 25) as in other members of genus. Mandible with 5 terminal teeth. Second maxilla (fig. 26) with terminal claw, segment bearing claw with patch of prominent spinules. Maxilliped (fig. 27) chelate, tip of movable process bearing broad scalelike spine opposed by process on preceding segment.

Legs 1–4 biramose, covered with stout spinules. Spine and setal formula as follows:

	leg 1		*leg 2*		*leg 3*		*leg 4*	
	exo.	end.	exo.	end.	exo.	end.	exo.	end.
seg. 1	I:0	0:0	I:0	0:0	I:0	0:0	I:0	0:0
seg. 2	I:0	0:0	I:0	0:0	I:0	0:0	I:0	0:0
seg. 3	3	2	II	I	III	1	III	1

Leg 1 (fig. 28) with 1 long and 1 short seta at tip. Outer edges of segments on exopod and endopod with rows of pointed spines as in figure. Leg 2 (fig. 29) exopod elongate as in figure, terminal exopod segment bearing 2 short inner spines. Second exopod segment reduced. First exopod segment with prominent lobe on inner distal corner. Endopod without spines and setae except for very small spine at tip. Leg 3 (fig. 30) exopod with well-developed spines on outer corners of segments. Endopod unarmed except for terminal seta. Leg 4 same as leg 3. Leg 5 (see fig. 21) broad lobe with 3 distal setae and 1 basal seta. Lobe covered with spinules. Leg 6 (see fig. 21) reduced to single short spine on genital segment at area of egg string attachment.

Egg strings uniseriate.

MALE.—Unknown.

REMARKS.—This species can be distinguished from all other members of the genus by the prominent lobe on the inner distal corner of the first exopod segment of leg 2. It is further characterized by the conspicuous spinules on the rami of legs 1–5.

Habitat: Gill filaments.

The name *pusilla*, from Latin, meaning "small," refers to the size of the species.

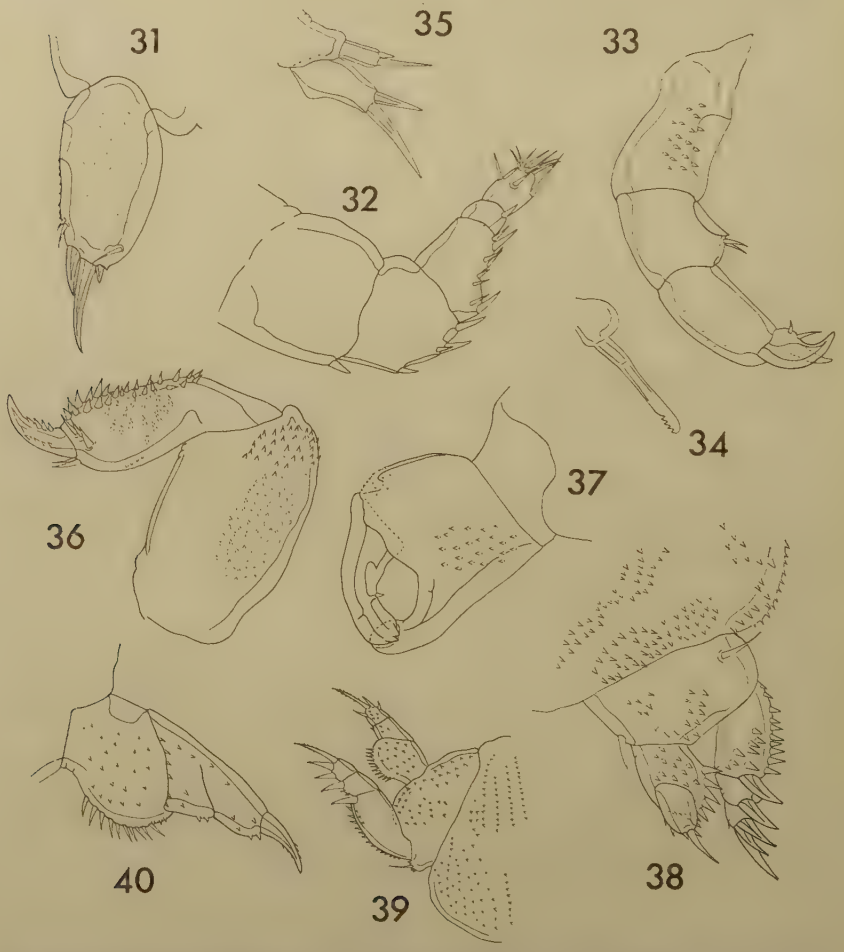
Eudactylina pollex, new species

FIGURES 4, 31–42

Collection: 23 females from 1 specimen of *Sphyrna mokarran* at station 409. Holotype female USNM 113297. Paratypes (21 females) USNM 113298. One specimen dissected for study.

FEMALE.—Body form as in figure 4. Dorsal surface of body smooth. Total length 3.6 mm. Greatest width 0.8 mm. Cephalon slightly longer than wide (0.72 by 0.66 mm). First pedigerous thoracic segment fused with head. Thoracic segments 3–5 free,

measuring 360μ, 600μ, and 960μ, respectively. Thoracic segment bearing leg 5 free, not combined to form genital segment. Genital segment somewhat wider than long (300μ by 340μ). Abdomen 2-segmented, segments measuring 141μ and 118μ, respectively. Caudal rami (fig. 31) about twice as long as wide (132μ by 75μ), bearing 3 terminal spines and 3 subterminal setae. Rami covered with spinules on dorsal surface.



FIGURES 31–40.—*Eudactylina pollex*, new species, female: 31, caudal ramus; 32, first antenna; 33, second antenna; 34, mandible; 35, first maxilla; 36, second maxilla; 37, maxilliped; 38, first leg; 39, second leg; 40, endopod of third leg.

Oral area as in other members of genus. First antenna (fig. 32) 5-segmented, each segment armed with short, naked setae as in figure. Second antenna (fig. 33) 4-segmented. Terminal segment in

form of short claw bearing 3 spines. Second segment with 2 short setae on inner margin. Mandible (fig. 34) styliform process projecting with mouth tube, armed with 4 teeth at tip. Second maxilla (fig. 36) with patches of stout spinules as in figure. Maxilliped (fig. 37) chelate. Movable process of maxilliped opposed by immovable dactylate process on preceding segment. Immovable process with distal depression into which tip of movable process fits.

Legs 1–4 biramose with spine and setal formula as follows:

	leg 1		*leg 2*		*leg 3*		*leg 4*	
	exo.	end.	exo.	end.	exo.	end.	exo.	end.
seg. 1	I:0	0:0	I:0	0:0	I:0	0:0	I:0	0:0
seg. 2	I:0	1	I:0	0:0	I:0	0:0	I:0	1
seg. 3	III		III	4	III	1	III	

Leg 1 (fig. 38) bearing stout spinules on both rami. Exopod 3-segmented. Endopod 2-segmented. Leg 2 (fig. 39) with both rami 3-segmented, small spinules on both rami. Leg 3 similar to leg 4 except endopod last segment incompletely divided (fig. 40). Leg 4 (fig. 41) endopod 2-segmented. Exopod 3-segmented. Exopods of legs 2–4 with few spinules on first segment only. Leg 5 (fig. 42) a lateral lobe on thoracic segment 6, bearing 2 terminal setae, 1 subterminal seta. Leg 6 represented by short spine incorporated into area of egg string attachment.

Egg strings uniseriate.

MALE.—Unknown.

REMARKS.—This new species can be separated from all known species of the genus (except *E. acanthii* Scott, *E. turgipes* Bere, and *E. corrugata* Bere) by the exopod of leg 2. In all other species the exopod is unusually long and somewhat recurved (compare figs. 29 and 39). *E. pollex* can be separated from the other 3 species by the segmentation of the legs. In *E. acanthii* and *E. corrugata* the exopods of legs 1–4 are 2-segmented. In *E. pollex* the exopods of legs 2 and 3 are 3-segmented. The endopod of leg 4 of *E. turgipes* is 3-segmented. It is 2-segmented in *E. pollex.*

Habitat: Gill filaments.

The name *pollex,* from Latin, meaning "thumb," refers to the shape of the endopods of legs 2–4.

Kroyeria gracilis Wilson, 1932

Collections: From 3 specimens of *Carcharinus leucas* from Nosy Bé; from 1 specimen of the same host from station 409; from 1 specimen of *Carcharinus longimanus* from station 291.

Habitat: Gill filaments.

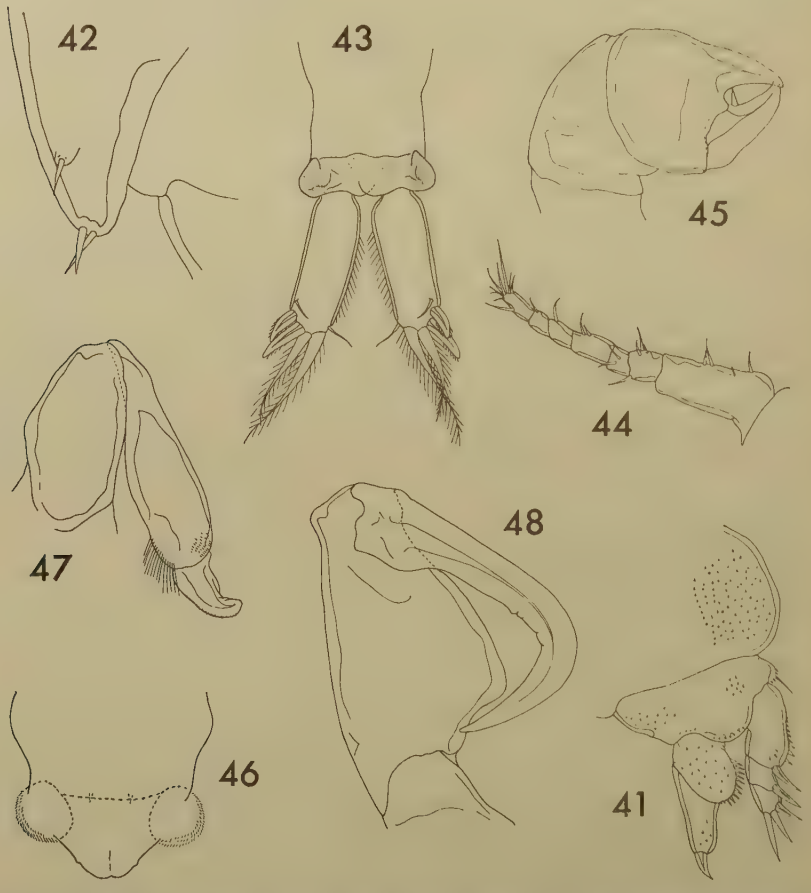
This copepod has been reported from a wide range of hosts and is probably cosmopolitan in distribution.

***Kroyeria dispar* Wilson, 1935**

Collections: From 3 specimens of *Galeocerdo cuvier* from Nosy Bé.

Habitat: Gill filaments.

The only previous report of this copepod is the original description from Puerto Rico from *Squalus*.



FIGURES 41–48.—*Eudactylina pollex*, new species, female: 41, fourth leg; 42, fifth leg. *Kroyeria gemursa*, new species, female: 43, distal end of abdomen and caudal rami; 44, first antenna; 45, second antenna; 46, labrum; 47, second maxilla; 48, maxilliped.

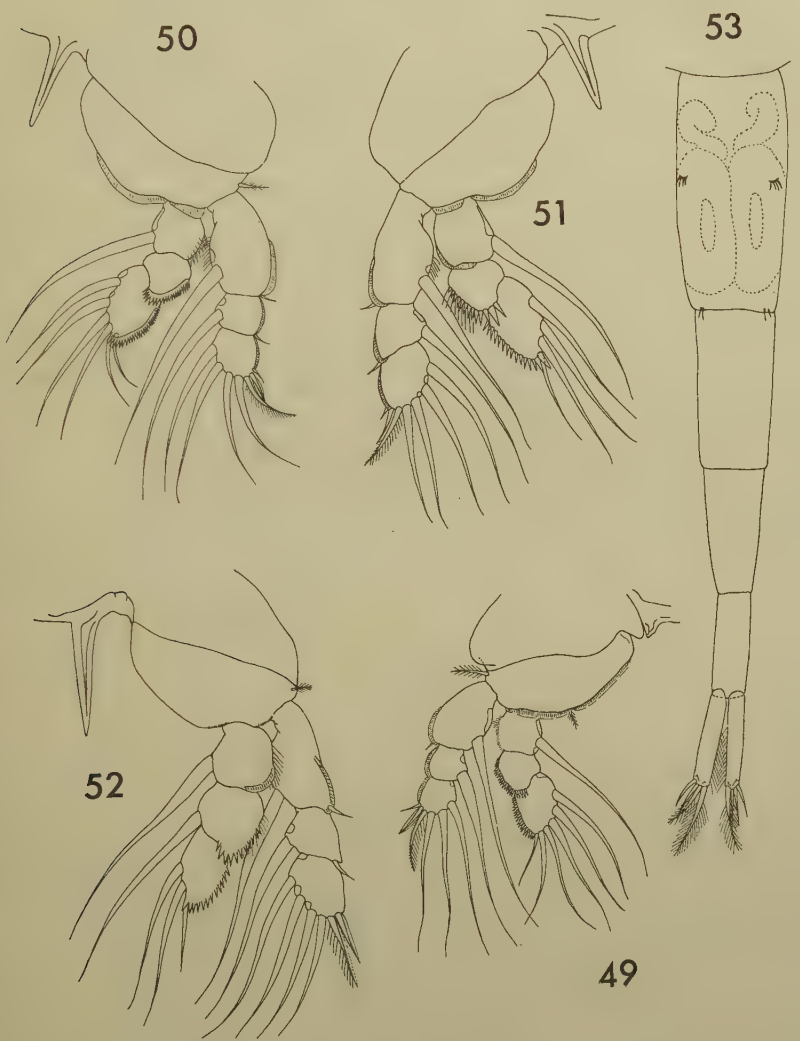
***Kroyeria spatulata* Pearse, 1948**

Collections: From 5 specimens of *Carcharinus maculipinnis*, 2 specimens of *Carcharinus sorrah*, and 2 specimens of *Rhizoprionodon acutus* all from Nosy Bé.

Habitat: Gill filaments.

This copepod has been reported previously from off the southeast coast of the United States. The previously reported hosts

plus the new records here indicate that this species may be restricted to sharks generally found only in shallow coastal waters.



FIGURES 49–53.—*Kroyeria gemursa*, new species, female: 49, first leg; 50, second leg; 51, third leg; 52, fourth leg. Male: 53, genital segment, abdomen and caudal rami.

Kroyeria gemursa, new species

FIGURES 5, 43–53

Collections: 4 females and 4 males from 1 specimen of *Sphyrna mokarran* at station 409. Holotype, female, USNM 113294. Allotype, male, USNM 113295. Paratypes (2 females, 3 males) USNM 113296. One female specimen dissected for study.

FEMALE.—Body form as in figure 5. Total length 9.7 mm. Greatest width 1.5 mm. Cephalon as wide as long (1.3 mm), widest near posterior border. Thoracic segments bearing legs 1–4 free. Segment bearing leg 1 with well-developed aciculum, 1.3 mm in length, bifid at tip. Thoracic segments 6 and 7 fused to form genital segment. Genital segment long, comprising slightly more than one-half body length. Abdomen 2-segmented. Terminal segment with posterior sclerotized ring at point of attachment of caudal rami (see fig. 43). Caudal rami (fig. 43) 3 times as long as wide (264μ by 94μ). Each ramus fringed along inner margin, bearing 4 terminal and 2 subterminal setae. Outer 2 terminal setae stout, plumose on inner margins only.

Oral area as in other members of genus. First antenna (fig. 44) 7-segmented, each segment with short, naked setae as in the figure. Second antenna (fig. 45) chelate. Movable process with short spine on inner margin, tips of immovable and movable processes pointed. Mouth tube short. Labrum with lateral spinose lobes. Mandible in form of stylet. First maxilla biramose. Second maxilla (fig. 47) with short, blunt claw at tip. Maxilliped (fig. 48) with long recurved claw. Maxilliped most prominent appendage of cephalon.

Legs 1–4 biramose; each ramus 3–segmented. Spine and setal formula as follows:

	leg 1		*leg 2*		*leg 3*		*leg 4*	
	exo.	end.	exo.	end.	exo.	end.	exo.	end.
seg. 1	I:1	0:1	I:1	0:1	I:1	0:1	I:1	0:1
seg. 2	0:1	0:0	I:1	0:0	I:1	0:0	I:1	0:1
seg. 3	II:4	6	II:5	6	II:4	4	II:4	3

Leg 1 (fig. 49) exopod with fringe on outer margin of all 3 segments. Outer margin of last 2 endopod segments with row of many short spines. Legs 2 (fig. 50) and 3 (fig. 51) rami with outer margins armed as leg 1. Leg 4 (fig. 52) exopod with fringe on first segment only. Endopod outer margin as in preceding legs. Each corner of intercoxal plate of legs 2–4 with well-developed, posteriorly directed spine. Corners of intercoxal plate of leg 1 with knobs. Leg 5 represented by 4 setae located on margin near middle of genital segment. Setae arranged in 2 groups of 2 setae each. Leg 6 a single seta at posterior corner of genital segment.

Egg strings uniseriate.

MALE.—Body form and appendages like those of female. Total length 4.4 mm. Greatest width 1.0 mm. Male differs from female in form of genital segment, abdomen, and caudal rami (fig. 53). Abdomen 3-segmented, end of abdomen not sclerotized as in female. Caudal rami nearly 6 times as long as wide (352μ by 61μ).

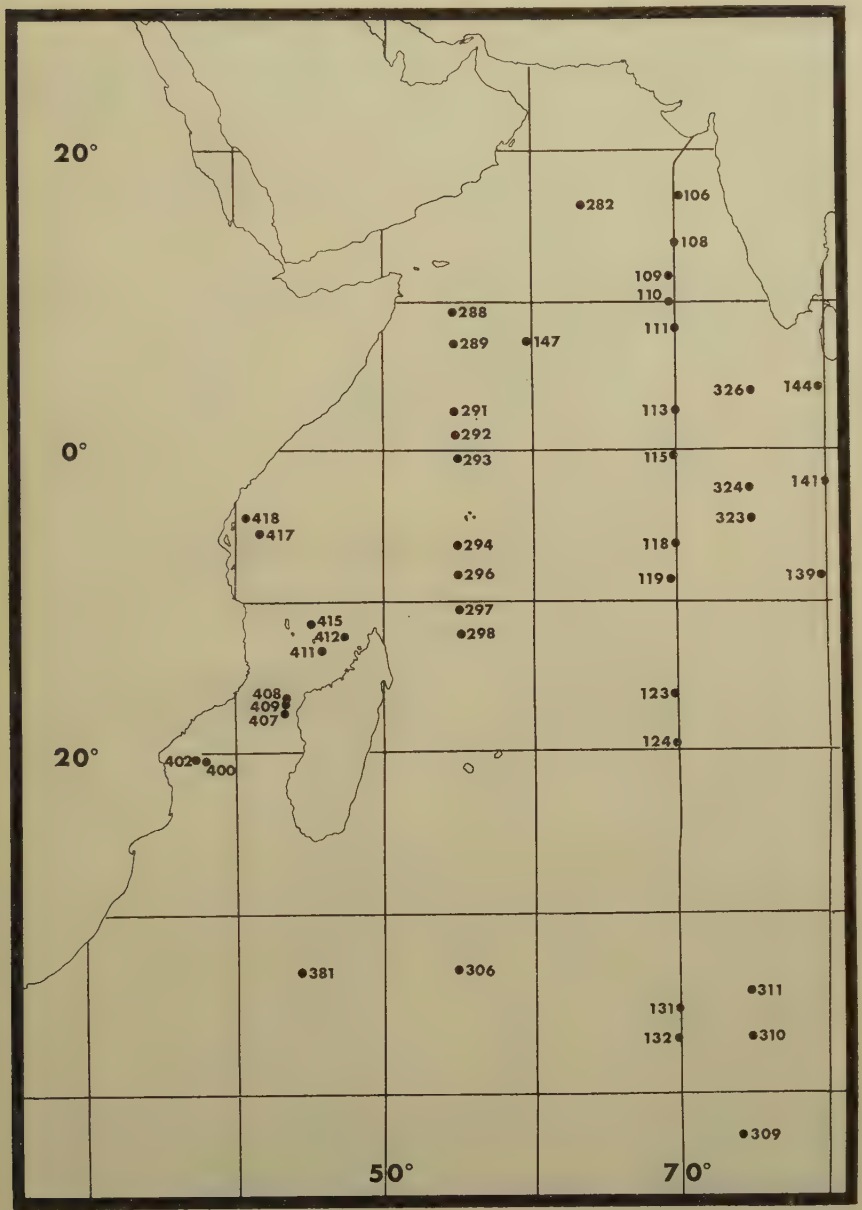


FIGURE 54.—Map of Indian Ocean showing various stations of the R/V *Anton Bruun* cited in this paper.

Legs 1–4 armed as in female except spines on outer edges of endopod segments fewer in male. Leg 5 as in female. Leg 6 consisting of 2 setae on posterior corner of genital segment.

Spermatophores easily visible within genital segment.

REMARKS.—*Kroyeria gemursa* can be separated from all known members of the genus by the sclerotized area at the end of the abdomen. It can be further distinguished from all species except *K. dispar* by the lateral swellings on the labrum. It can be separated from *K. dispar* by the presence of the prominent spines on the intercoxal plates of legs 2–4.

Habitat: Gill filaments.

The name *gemursa,* from Latin, meaning "swelling between toes," refers to sclerotization on abdomen.

***Bariaka alopiae* Cressey**

Collection: From 1 specimen of *Alopias superciliosus* at Nosy Bé and station 119.

Habitat: Gill filaments.

Copepods Parasitic on Sharks Examined

Lamnidae

Isurus oxyrinchus
- *Pandarus smithii*
- *Echthrogaleus denticulatus*
- *Dinemoura latifolia*
- *Nemesis lamna*
- *Anthosoma crassum*

Isurus glaucus
- *Dinemoura latifolia*

Isurus species
- *Anthosoma crassum*
- *Nemesis lamna*

Lamna species
- *Echthrogaleus coleoptratus*

Carcharodon carcharias
- *Pandarus cranchii*
- *Nesippus orientalis*
- *Nemesis lamna*

Alopidae

Alopias vulpinus
- *Pandarus cranchii*
- *Pandarus smithii*
- *Gangliopus pyriformis*
- *Echthrogaleus denticulatus*
- *Dinemoura* sp.
- *Nemesis aggregatus*

Alopias superciliosus
- *Dinemoura* species
- *Pagina tunica*
- *Bariaka alopiae*

Triakidae

Mustelus species
- *Perissopus dentatus*

Carcharinidae

Carcharinus longimanus
- *Pandarus cranchii*
- *Nesippus crypturus*
- *Alebion gracilis*
- *Kroyeria gracilis*

Carcharinus floridanus
- *Pandarus cranchii*
- *Pandarus smithii*
- *Nesippus crypturus*

Prionace glauca
- *Pandarus satyrus*
- *Phyllothereus cornutus*
- *Gangliopus pyriformis*
- *Echthrogaleus coleoptratus*

Galeocerdo cuvier
- *Nesippus orientalis*
- *Nesippus crypturus*
- *Nesippus* sp.
- *Alebion gracilis*
- *Kroyeria dispar*
- *Eudactylina pusilla*

Carcharinus obscurus
- *Perissopus dentatus*
- *Alebion gracilis*

Carcharinus obesus?
Pseudopandarus longus
Carcharinus leucas
Pandarus carcharini
Perissopus dentatus
Nesippus orientalis
Nesippus crypturus
Alebion gracilis
Paralebion elongatus
Nemesis robusta
Kroyeria gracilis
Carcharinus maculipinnis
Pandarus carcharini
Nesippus orientalis
Nesippus crypturus
Nemesis versicolor
Eudactylina aspera
Kroyeria spatulata
Carcharinus limbatus
Alebion alatus
Carcharinus albimarginatus
Alebion gracilis
Carcharinus spallanzani
Pandarus niger
Carcharinus tjutjot
Pseudopandarus longus
Perissopus dentatus
Carcharinus sorrah
Kroyeria spatulata
Scoliodon palasorrah
Pseudopandarus gracilis
Nesippus orientalis
Rhizoprionodon acutus
Pseudopandarus longus
Nesippus orientalis
Eudactylina aspera
Kroyeria spatulata
Rhizoprionodon species
Pseudopandarus longus
Scoliodon species
Pseudopandarus gracilis
Carcharinus species
Pandarus niger
Alebion gracilis
Sphyrnidae
Sphyrna mokarran
Nesippus orientalis
Nesippus crypturus
Alebion elegans
Nemesis robusta
Eudactylina pollex
Kroyeria gemursa
Sphyrna lewini
Nesippus orientalis
Nesippus crypturus
Nemesis robusta
Eudactylina aspera
Sphyrna zygaena
Nesippus orientalis

Literature Cited

ABILDGAARD, P. C.
1794. Beskrivelse over tvende nye Monoculi Linn., Caligi Mull. (*Caligus crassus* et *oblongus*). Skr. Nat. Hist. Selskabet-Kjobenhavn, vol. 3., no. 2, pp. 46–54.

BENEDEN, P. J., VAN
1851. Recherches sur quelques Crustacès inférieurs. Ann. Sci. Nat., vol. 14, no. 3, pp. 71–131.

BERE, R.
1930. The parasitic copepods of the fish of the Passamaquoddy Region. Contr. Canadian Biol. Fish., vol. 5, no. 13, pp. 1–10.
1936. Parasitic copepods from the Gulf of Mexico fish. American Midl. Nat., vol. 17, no. 3, pp. 577–625.

CAPART, A.
1953. Quelques copépodes parasites de poissons marins de la région de Dakar. Bull. Inst. Francaise Afrique Noire, vol. 15, no. 2, pp. 647–671.

Cressey, R. F.
1963. A new genus of copepods (Caligoida, Pandaridae) from a thresher shark in Madagascar. Cah. O.R.S.T.O.M. Oceanogr., ser. Nosy Bé, vol. 2, no. 6, pp. 285–297.
1966. *Bariaka alopiae* n. gen. n. p. (Copepoda, Caligoida), a parasite on the Gills of the Thresher Shark in Madagascar. Bull. Mar. Sci., vol. 16, no. 2, pp. 324–329.
1967. A revision of the family Pandaridae. Proc. U.S. Nat. Mus., vol. 121, no. 3570, pp. 1–133.

Dana, J. D.
1852. Crustacea, pt. 2. Vol. 13 *in* United States exploring expedition . . . 1838–1842 . . ., pp. 691–1618.

Gerstaecker, A.
1854. Beschreibung zweier neuer Siphonostomen-Gattungen. Arch. Naturg., vol. 20, no. 1, pp. 185–195.

Gnanamuthu, C. P.
1951. New copepod parasites of sharks. Ann. Mag. Nat. Hist., vol. 4, ser, 12, pp. 1236–1256.

Guérin-Meneville, F. E.
1837. Crustacés. Vol. 26 *in* Iconographie du regne animal.

Heller, C.
1868. Crustaceen. No. 8 *in* vol. 2 *of* Zoologischer Teil *in* Reise der Oesterreichischen Fregatte *Novara* . . ., 280 pp., 25 pls.

Ho, J. S.
1963. On five species of Formosan parasitic copepods belonging to the suborder Caligoida. Crustaceana, vol. 5, pt. 2, pp. 81–98.

Kirtesinghe, P.
1950. Parasitic copepods of fish from Ceylon, 3. Parasitology, vol. 40, nos. 1 and 2, pp. 77–86.

Leach, W. E.
1819. Entomostraca. *In* vol. 14 *of* Dictionaire des sciences naturelles, pp. 524–545.

Milne-Edwards, H.
1840. Histoire naturelle des crustacés comprenant l'anatomie, la physiologie et la classification de ces animaux, 638 pp.

Pearse, A. S.
1948. A second report on parasitic copepods collected at Beaufort, N.C. Journ. Elisha Mitchell Sci. Soc., vol. 64, no. 1, pp. 127–131.
1951. Parasitic Crustacea from Bimini, Bahamas. Proc. U.S. Nat. Mus., vol. 101, no. 3280, pp. 341–372.

Rathbun, R.
1886. Descriptions of parasitic copepoda belonging to the genera *Pandarus* and *Chondracanthus*. Proc. U.S. Nat. Mus., vol. 9, pp. 310–324.

Risso, A.
1826. Histoire naturelle des principales de l'Europe Méridionale et particulièrement ce celles des environs de Nice et des Alpes Maratimes, vol. 5, 135 pp.

Scott, A.
1929. The copepod parasites of Irish Sea fishes. Rep. Lancashire Sea Fish Lab. 1929, pp. 81–118.

Scott, T.
1901. Notes on some parasites of fishes. 19th Ann. Rep. Fish. Bd. Scotland, pt. 3, pp. 120–153.
Shiino, S. M.
1957. Copepods parasitic on Japanese fishes, 15: Eudactylinidae and Dichelesthiidae. Rep. Fac. Fish. Pref. Univ. Mie, vol. 2, no. 3, pp. 392–410.
Smith, S.
1874. Invertebrate animals of Vineyard Sound and adjacent waters. Rep. Comm. Fish Fisheries 1871–1872, 478 pp., 38 pls. [Reference not seen.]
Steenstrup, J. J. S., and Lütken, C. F.
1861. Bidrag til Kundskab om det aabne Havs Snyltekrebs og Lernaeer samt om nogle andre nye eller hidtil kun ufuldstaen digt kjendte parasitiske Copepoder, vol. 5, pp. 341–432.
Vaissiere, R.
1959. Parasites de poissons de mer ouest-africains recoltes par J. Cadenat, 2: Copepodes. Bull. Inst. Francais Afrique Noire, vol. 21, ser. A, no. 2, pp. 534–553.
Wilson, C. B.
1905. New species of parasitic copepods from the Massachusetts Coast. Proc. Biol. Soc. Washington, vol. 18, pp. 127–132.
1911. North American parasitic copepods: Descriptions of new genera and species. Proc. U.S. Nat. Mus., vol. 39, pp. 625–634.
1913. Crustacean parasites of West Indian fishes and land crabs, with descriptions of the new genera and species. Proc. U.S. Nat. Mus., vol. 44, pp. 189–277.
1922. North American parasitic copepods belonging to the family Dichelesthiidae. Proc. U.S. Nat. Mus., vol. 60, pp. 1–100.
1932. The copepods of the Woods Hole Region, Massachusetts. U.S. Nat. Mus. Bull. 158, 635 pp.
1935. New parasitic copepods. Smithsonian Misc. Coll., vol. 91, no. 19, pp. 1–9.
Yamaguti, S.
1963. Parasitic Copepoda and Branchiura of fishes, 1104 pp.